European IWT Platform

Biofuels for inland vessels

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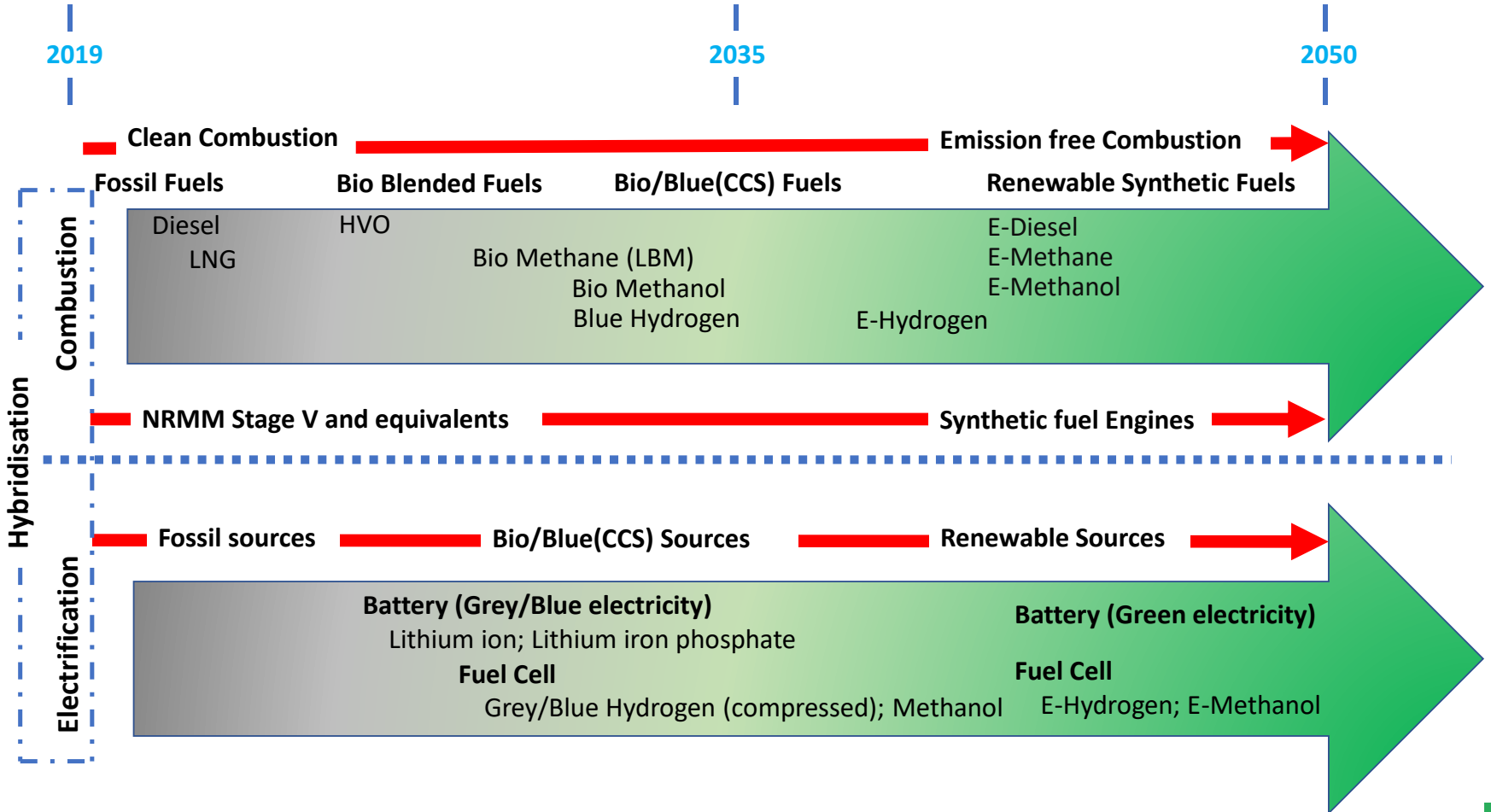
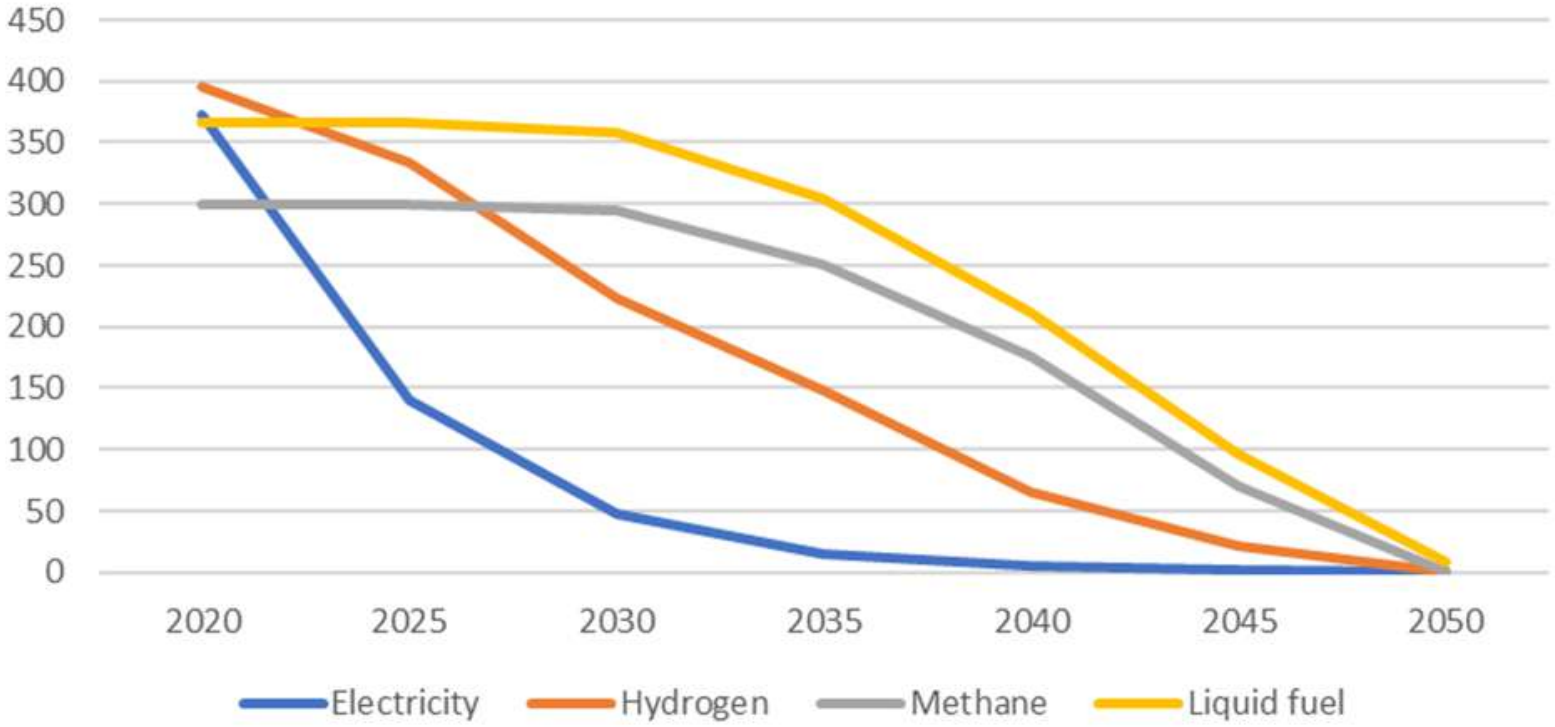
28 June 2021

Webinar IWT's Greening Challenges and Stage V - Perfect match or not?

Transition pathways to zero-emission in 2050



Expectation WTW GHG emission performance (gram per kWh, Well-To-Wake)



Combustion engines will remain for the next decades

- Clean combustion engine technologies will further develop, next steps possible after the Stage V implementation. Euro VI and Stage V NRE already achieve huge emission reductions for PM and NOx emissions.

- Biofuels to be used as drop-in solutions using the existing engines and bunker infrastructure, while other zero-emission solutions in general require much more capex and opex. An exemption may be battery-electric sailing for container vessels (pay –per- use).

Price expectations for fuel/energy in euro per GJ for application in inland waterway transport

Scenario	Fossile diesel	BioDiesel/HVO	BioMethane	BioMethanol	Green H2 (compressed)
2020-2030 low	€ 11,11	€ 14,03	€ 16,00	€ 16,00	€ 33,33
2020-2030 high	€ 19,17	€ 27,50	€ 28,00	€ 28,00	€ 50,00
2030-2040 low	€ 14,51	€ 18,00	€ 16,00	€ 16,00	€ 22,92
2030-2040 high	€ 22,41	€ 35,00	€ 31,00	€ 31,00	€ 41,67

Prices of hardware

Costs	Euro per kW
CCR 2 engine	250
Stage V / Euro VI engine diesel	375
Stage V / Euro VI engine hydrogen	550-550
Stage V / Euro VI methanol (engine and tank)	600-650
Stage V / Euro V cryogenic gas propulsion (engine and tank)	1100-1400
Installtion costs for electric engines including interface	420-580
Fuel cell (note: lifetime of FC is significanly lower compared to ICE)	2030: 1500 – 2500 euro per kW 2040: 1000 – 2000 euro per kW
H2 tank container	2030: 800 – 1000 euro per kg 2040: 528 – 800 euro per kg
Pay-per-use battery container Energie contents exchangable battery (ISO-20 voet)	16-21 cents per kWh at exchange each 12 hrs 3 MWh in 2030, 5 MWh in 2040

TCO drivetrain propulsion of vessel, 2020-2030

Case Studies	Stage V+ / Euro VI	BioDiesel Stage V+ / Euro VI	BioMethane Stage V+ / Euro VI	Battery electric sailing container (low exchange frequency)	Battery electric sailing container (high exchange frequency)	H2 500b (container) FC (low exchange frequency)	H2 500b (container) FC (high exchange frequency)	Bio-Methanol FC	H2 500b (container) ICE (low exchange frequency)	H2 500b (container) ICE (high exchange frequency)	Bio-Methanol ICE
Case 1 Alphen-Moerdijk container transport (90m vessel/104TEU)	1.1	1.5	1.8	1.8	1.5	3.5	3.7	3.0	3.0	3.2	1.6
Case 2 Rotterdam-Bovenrijn container transport (185m coupled convoy/342TEU)	1.1	1.5	1.9	8.3	2.4	4.9	4.0	3.6	3.7	2.8	1.6
Case 3 Rotterdam-Duisburg container transport (135m vessel / 336TEU)	1.2	1.5	2.1	7.7	2.2	5.2	3.9	4.5	3.4	2.1	1.7
Case 4 Rotterdam-Duisburg push convoy (pusher with 4-6 barges, total avg. 12,000 tons)	1.1	1.4	1.9					3.6			1.6
Case 5 Den Haag-Rotterdam waste transport (67m vessel/500ton)	1.1	1.5	2.1	3.3	3.3	4.3	4.3	3.3	3.7	3.7	1.9
Case 6 Trierveld-Den Haag sand & gravel transport (70m vessel/1010ton)	1.2	1.6	2.0	6.5	3.7	4.3	4.2	3.7	3.3	3.2	1.8
Case 7 ARA liquid bulk transport (135m vessel/6280ton)	1.1	1.5	2.0	3.8	2.5	4.2	4.0	3.8	3.1	2.9	1.7

Note: simplified overview of overall annual costs for the powertrain, covering capital costs, operational costs as well as other costs.

Factor of the TCO compared to using a CCNR II diesel engine. Average price scenario for period 2020-2030.

TCO drivetrain propulsion of vessel, 2030-2040

Case Studies	Stage V+ / Euro VI	BioDiesel Stage V+ / Euro VI	BioMethane Stage V+ / Euro VI	Battery electric sailing container (low exchange frequency)	Battery electric sailing container (high exchange frequency)	H2 500b (container) FC (low exchange frequency)	H2 500b (container) FC (high exchange frequency)	Bio-Methanol FC	H2 500b (container) ICE (low exchange frequency)	H2 500b (container) ICE (high exchange frequency)	Bio-Methanol ICE
Case 1 Alphen-Moerdijk container transport (90m vessel/104TEU)	1.1	1.5	1.6	1.04	1.05	2.3	2.4	2.4	2.0	2.1	1.4
Case 2 Rotterdam-Bovenrijn container transport (185m coupled convoy/342TEU)	1.1	1.5	1.6	4.5	1.6	3.3	2.7	2.9	2.5	1.8	1.4
Case 3 Rotterdam-Duisburg container transport (135m vessel / 336TEU)	1.1	1.5	1.8	4.3	1.4	3.6	2.7	3.5	2.3	1.4	1.5
Case 4 Rotterdam-Duisburg push convoy (pusher with 4-6 barges, total avg. 12,000 tons)	1.1	1.5	1.6					2.9			1.4
Case 5 Den Haag-Rotterdam waste transport (67m vessel/500ton)	1.1	1.6	1.8	2.7	2.7	2.9	2.9	2.7	2.5	2.5	1.7
Case 6 Trierveld-Den Haag sand & gravel transport (70m vessel/1010ton)	1.2	1.6	1.7	4.2	3.0	2.9	2.8	2.9	2.2	2.1	1.5
Case 7 ARA liquid bulk transport (135m vessel/6280ton)	1.1	1.5	1.7	2.3	1.6	2.9	2.8	3.0	2.1	2.0	1.5

Note: simplified overview of overall annual costs for the powertrain, covering capital costs, operational costs as well as other costs.

Factor of the TCO compared to using a CCNR II diesel engine. Average price scenario for period 2030-2040.

Availability

- Use of biofuels by other modes, notably sea transport and aviation?
- There is a wide availability of feedstocks
- Use of unsustainable feedstocks is capped in Renewable Energy Directive
- Focus on feedstocks with good well-to-tank performance
- Advanced feedstocks to be further developed and production to be enlarged
- In further future, possibly blends with e-fuels (green hydrogen) and biofuels.
- However, e-fuels will require more energy, probably at high price levels

Technical application

- Biodiesel in pure or blended form is being applied in the NRMM sector:
  - HVO, e.g. HVO30, HVO100
  - ChangeTL (80% GTL, 20% FAME)
  - FAME (B7)

- EN14214 standard for FAME
- EN 15940 standard for HVO

Technical application – engine type approval legislation

Pre CCR < 2002	CCRI 2002 – 2007	CCRII 2007-2020	Stage V >2020
Not regulated	- Max 7% FAME (B7) - 30% HVO - Total maximum 37% biofuel (volume)		- Maximum 8% FAME (B8), - 30%HVO If certified more possible: blends up to 100% FAME and HVO - Synthetic blends, e.g. GTL+FAME - 100% bio-methane (bioLNG)

Technical application – guidelines engine suppliers

Pre CCR < 2002	CCRI 2002 – 2007	CCRII 2007-2020	Stage V >2020
Hardly information available. Problems may occur with FAME blends over 7%	B7 possible With adaptation measures and good housekeeping, B20-B30 is possible.	B7 possible With adaptation measures and good housekeeping, B20-B30 is possible. 30% HVO upto 100% HVO also approved by some engine suppliers	Always B7 and HVO30 possible HVO100 for Euro VI No further information yet available on additional blends. More expected for Euro VI and NRE

Technical application - FAME

- Attention needed for FAME application, technical compatibity:
  - Fuel filters, fuel pumps, fuel injectors, corrosion/MIC, seals, fuel hoses
  - Need for 'good housekeeping'
  - Cleaning of tank
  - Currently FAME bunkers need to be consumed within a relatively short period
  - Sensitive to temperature (winter / summer quality), sensitive to high pressure and temperature
  - **Need for more strict quality standards for (FAME) blends**

Technical application - FAME

- Further research planned:
  - Risks in fuel supply chain
  - Impact of blending and additives
  - Risks and sensitivities in storage and engines in inland vessels
  - Current or more strict technical quality specification of biofuels/FAME:
    - Cloud Point (CP)
    - Saturated monoglyceride effects (SMG), e.g. **40** as new limit?
    - (Cold) Filter Blocking Tests at different temperatures 25, 3, -1°C
    - Oxidation Stability requirements
    - % mono-glycerides, % sterolglycosides
    - % water (<200 mg/kg)

Fuel price impact - factors

- Blend rate and type of feedstock
- Prices of feedstocks and price of fossil fuel (note: strong fluctuations)
- Governmental policies and cross-subsidy mechanisms (e.g. HBE tickets in NL)
- Demand from other modes and sectors of economy
- How fuel suppliers balance revenues/costs between modes (e.g. overblending)
- Competition between fuel suppliers
- Policy developments (RED 2 implementation, ETD, RED 3)
- Availability and applicability of other technologies and energies
- Level playing field in Europe

Fuel price impact – indicative / current prices

Commodity prices	Prijs difference to diesel	Prices	
	€/ton	€/ton	€/GJ
Diesel		500	11.9
FAME - UCO (UCOME)	+775	1275	34.3
FAME - PPO, winter quality	+460	960	25.8
FAME - PPO, summer quality	+350	850	22.8
HVO – UCO	+1265	1765	40.0
HVO – PPO	+1050	1550	35.1

Concluding

- Biofuels are very well positioned to make big contributions, notably HVO and LBM on short and medium term.
- Points of attention:
  - Production volume from sustainable feedstocks
  - Quality standards for blends (FAME)
  - Engine certification
  - Level playing field
  - Supporting policies and incentives
  - Awareness amoung users (good housekeeping)

Thank you for your attention!

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